Senior Thesis

# Mixing of Water in the Scioto River at Chillicothe, Ohio

by
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Approved by:

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**ABSTRACT**

A study of Scioto River waters and its tributaries was conducted on August 5, 1994 in and around Chillicothe, Ohio. Samples of main- stream and tributary waters were taken at twelve locations. These sites were chosen to best illustrate mixing of water at confluences, discharge of anthropogenic effluent within city limits, and changes in chemical composition along the main stream. Each sample was analyzed for its concentrations of six conservative elements: Na, Ca, Mg, K, Sr, and S. Element-pair diagrams show mixing of surface water components based on two components. The results indicate that the concentration of water from Paint Creek is 22.3% $\pm$ 2.03% of the water in the Scioto River below the confluence. The discharge of Paint Creek was estimated to be 271 cfs $\pm$ 31 cfs on the day the water samples were collected. Anthropogenic effluent entering Paint Creek acts as a third component of water causing mixtures containing anthropogenic effluent to deviate from the expected mixture of waters of the North and South forks of the river. Data taken along the length of the Scioto River indicate that elemental concentrations vary as a function of distance downstream. Sodium as well as S concentrations increase downstream as a result of anthropogenic inputs into the Scioto River. Ca, Mg, Sr, and K concentrations decrease due to a progressive dilution downstream by addition of dilute water along the course of the river in the study area.

**INTRODUCTION**

The study by Hicks (1994) on the chemical composition of water in the Scioto River suggests that the water at Chillicothe merits additional investigation. This current study presents a possible explanation for changes in the chemical composition of the Scioto River at Chillicothe by mixing of water over relatively short distances along the course of the river. In order to determine what is influencing the composition of water in the main stream, two-component mixing models were constructed based on conservative elements plotted against each other. These graphs were interpreted in terms of mixing of Scioto River water and specific tributaries or anthropogenic effluents.

For this purpose, a study of the Scioto River waters and its tributaries was conducted in and around the city of Chillicothe, in central Ross county, Ohio. (See Figure 1) Twelve water samples were collected on August 5, 1994 for chemical analysis. The samples were analyzed for specific conservative elements, these being: K, Na, Ca, Mg, Sr, and total S. Variations of the concentrations of these elements indicate how the water of the Scioto River is affected by the input of water from different sources having different chemical compositions.

The chemical composition of water in the main stream is affected by tributaries discharging into the major stream and

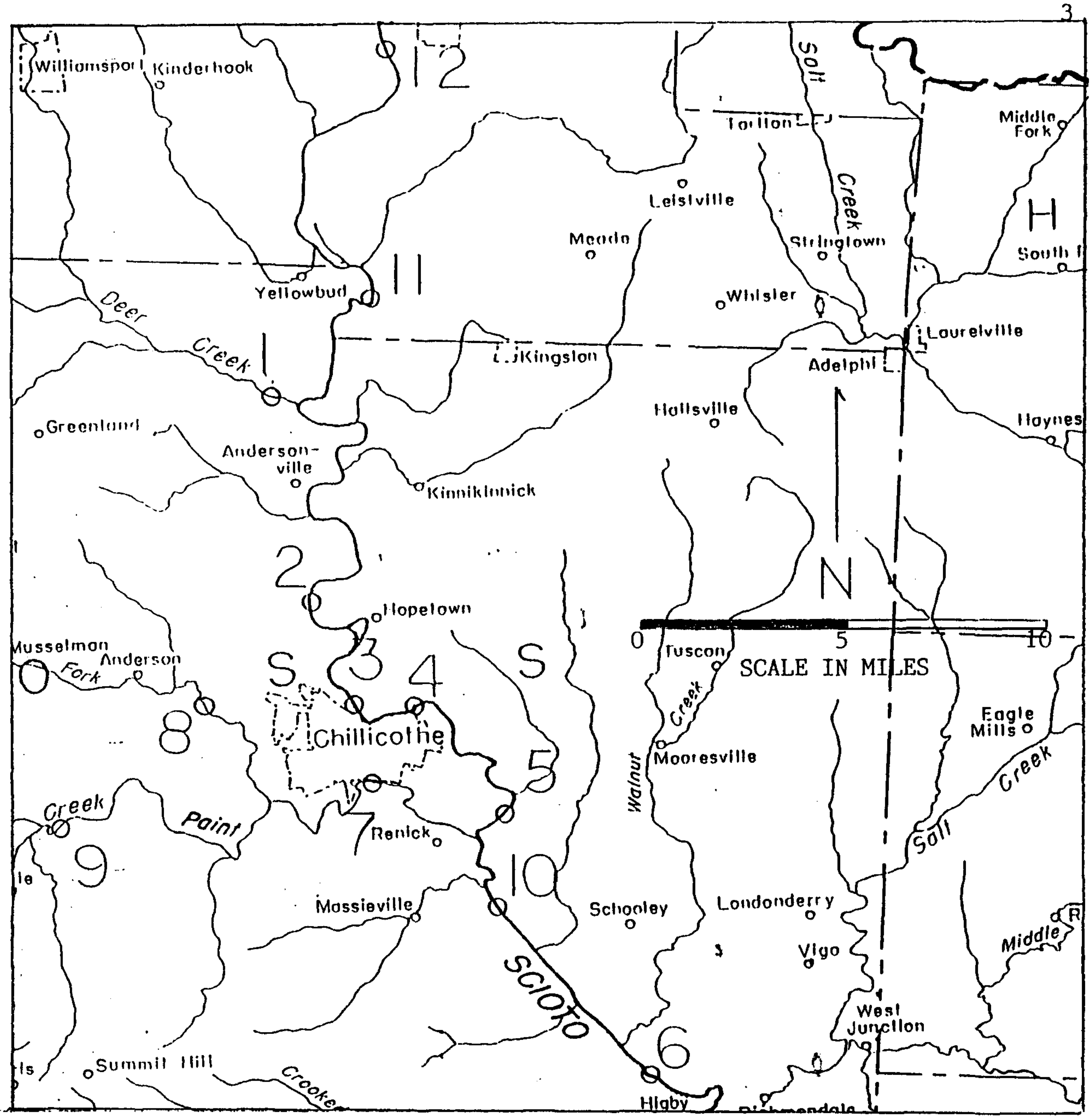



Figure 1. Map of study area around Chillicothe, Ohio. Sample locations numbered 1-12.

by anthropogenic effluents discharged at specific locations along the course of the Scioto River and its tributaries.

**DESCRIPTION OF COLLECTING LOCATIONS**

Water samples were collected at strategically placed sites to study the compositions of the Scioto River and various tributaries above and below their confluences. In addition, samples were taken along the length of the Scioto River within the study area to investigate the change in the chemical composition of water as a function of distance downstream.

The two major tributaries to the Scioto that were sampled are Paint Creek and Deer Creek. Deer Creek flows into the Scioto River about eight miles north of Chillicothe, whereas Paint Creek enters the Scioto River south of the city. Paint Creek has two branches identified as the Northern and Southern branch, both of which were sampled to test for the presence of anthropogenic sources of water within the city.

**FIELD METHODOLOGY AND ANALYTICAL PROCEDURE**

All samples were collected from bridges. At each location, a ten-liter bucket was lowered into the stream from the bridge. A single sample was obtained from each site, taken approximately from the center of the stream. Samples were poured into 500mL Neoprene bottles which were previously rinsed with sample water to prevent contamination. The samples were then chilled on ice in a cooler until they were transferred to a refrigerator where they remained prior to analysis. In the laboratory, the water was filtered using a 0.45μm Millipore filter under vacuum to remove clay and organic particulates. The samples were then acidified with 1mL of $HNO_3$ per 250mL aliquot. This preserved the sample by lowering the pH to less than 2. Back-up samples were preserved in the same manner.

Samples were analyzed by Inductively Coupled Plasma Spectrometry and Mass Spectrometry (ICP-MS). In order to ensure the calibration of the ICP-MS, standards for each element were prepared from two stock solutions within the range of concentrations of the unknowns as determined by Hicks (1994). The two stock solutions contained all of the elements being analyzed in this study.

One of the calibration solutions was re-analyzed after every second sample to detect electronic drift in order to assure the accuracy of results. The data indicated that the concentrations of all elements were within the sensitivity limits of the ICP-MS. Selenium, which was also analyzed but not used in this study, was below the sensitivity limits of the ICP-MS.

**PRESENTATION OF THE DATA**

The analytical data in Tables 1 to 18 (see appendices) reveal that calcium and sodium are the most abundant elements in each sample, presumably because of chemical weathering of calcite in carbonate rocks (Ca) and because of subsurface dissolution of Paleozoic salt deposits (Na). The four other elements: Mg, K, S, and Sr occur in substantially lower concentrations than Ca and Na. Magnesium is derived from weathering of dolomite and/or biotite, potassium from both biotite and K-feldspar, sulfur in the form of sulfate is a by-product of the weathering of pyrite and/or dissolution of gypsum, and strontium originates from calcite or celestite. The study area around the city of Chillicothe is underlain by Devonian shale and Mississippian carbonates, shales, and sandstones.

The concentrations of the elements determined in this study are listed in Table 1. Standard deviations are given in Tables 1 to 18 within the appendices.

**GRAPHICAL REPRESENTATION OF DATA**

Figures 2 to 4 are graphical representations of the data in the form of two-component mixing diagrams. The numbers correspond to sample sites shown on Figure 1. The concentrations of the elements are indicated along the axes. In each diagram the abscissa is the Na concentrations plotted versus one of the five conservative elements on the ordinate axis in order to preserve continuity among the diagrams. The coordinate axes are scaled to show the greatest detail.

| Sample | Element (ppm) | | | | | |
|---|---|---|---|---|---|---|
| | **Na** | **Mg** | **S** | **K** | **Ca** | **Sr** |
| 1 | 7.42 | 32.1 | 16.8 | 1.55 | 56.7 | 2.11 |
| 2 | 28.2 | 17.4 | 21.4 | 3.30 | 48.7 | 0.92 |
| 3 | 30.6 | 17.8 | 22.6 | 3.53 | 49.5 | 0.94 |
| 4 | 28.8 | 16.6 | 20.9 | 3.31 | 46.0 | 0.89 |
| 5 | 30.7 | 18.2 | 22.6 | 3.53 | 49.6 | 0.93 |
| 6 | 34.2 | 16.6 | 23.5 | 3.06 | 43.3 | 0.70 |
| 7 | 61.6 | 17.7 | 35.7 | 3.80 | 36.7 | 0.37 |
| 8 | 6.51 | 26.6 | 13.0 | 1.45 | 48.9 | 1.46 |
| 9 | 4.32 | 20.6 | 6.34 | 1.67 | 33.8 | 0.37 |
| 10 | 36.8 | 17.5 | 24.7 | 3.36 | 44.5 | 0.73 |
| 11 | 14.5 | 24.2 | 11.4 | 1.01 | 57.3 | 0.57 |
| 12 | 25.7 | 14.8 | 18.2 | 2.89 | 41.1 | 0.93 |

Table 1. Average chemical compositions of water samples from the Scioto River and its tributaries. Sample locations are identified in Figure 1.

Three major confluences were studied around Chillicothe: the Scioto River-Paint Creek confluence, the confluence between the North and South Branches of the Paint Creek, and Scioto River-Deer Creek. The resulting mixing diagrams are presented in figures 2 to 4.

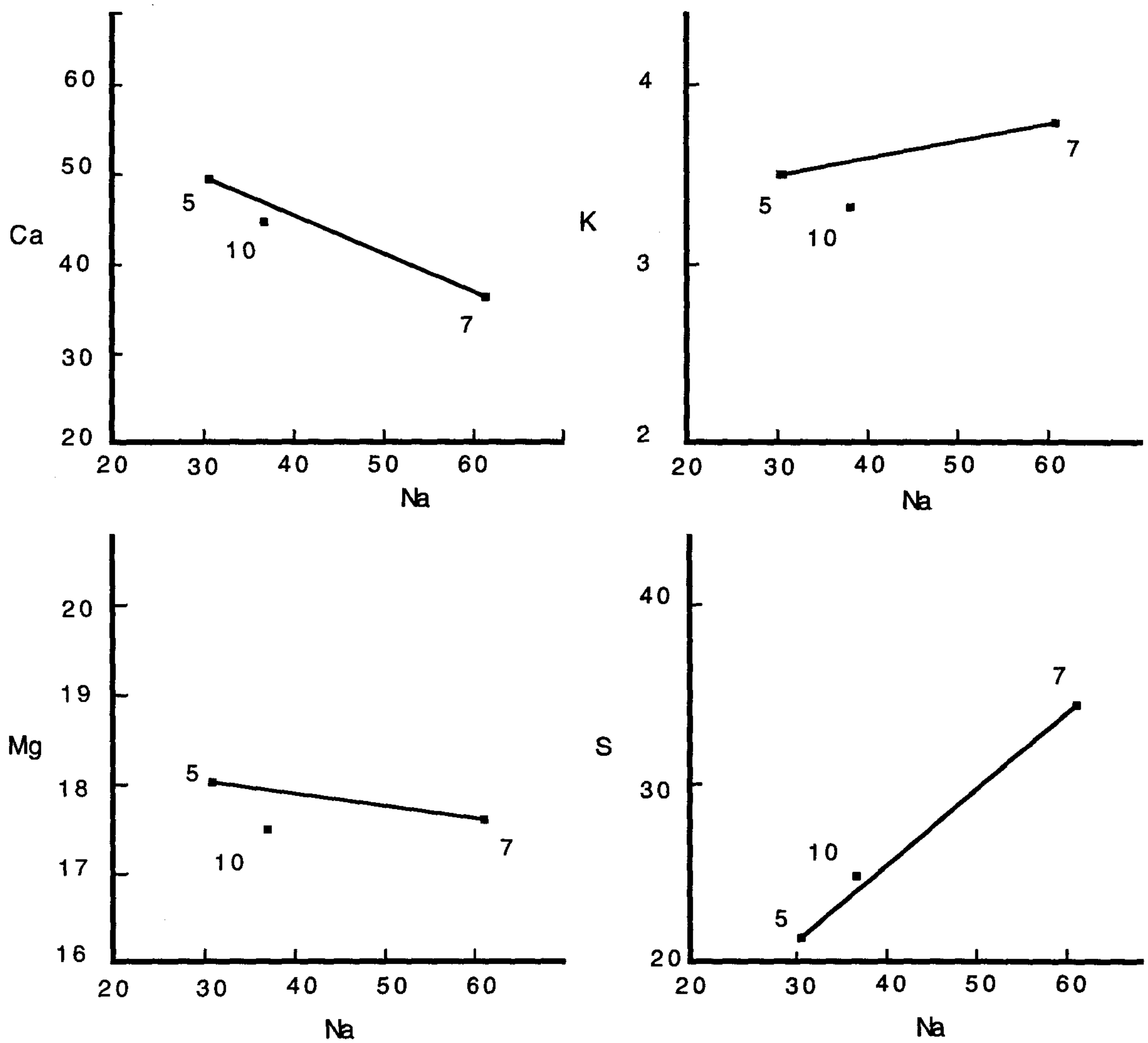
**Normal Mixing Model**

The Scioto River-Paint Creek confluence in Figure 2 contains five diagrams containing three data points each. Samples 5 and 10 from the Scioto River represent water from above and below the confluence, respectively. Sample 7 is from the Paint Creek.

The diagrams indicate that each set of samples shows a linear relationship. A line of mixing was constructed by connecting the two sources (5 and 7). Sample 10 represents mixtures of the two components whose concentrations can be determined from its position on the mixing line.

The procedure, illustrated in Figure 2a, involves measuring the distance "a" and dividing it by the distance "b" between the end members. The resulting ratio is converted into a percent representing the concentration of component A in mixture C.

The following data were calculated for the abundance of Paint Creek water (7) in sample 10 (Figure 2) using this method:



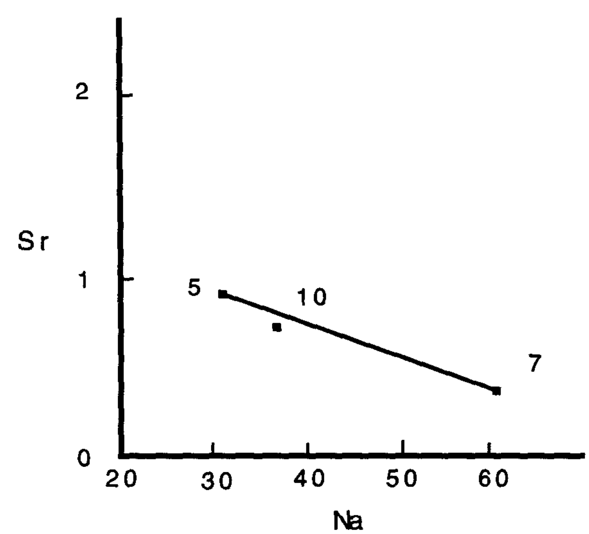




Figure 2. Concentration of element pairs in water of the Scioto River and Paint Creek, Chillicothe, Ohio. Sample 5: Scioto River above the confluence, sample 7: Paint Creek, sample 10: Scioto River below the confluence. Analytical errors are given by size of the symbols. All units in ppm.

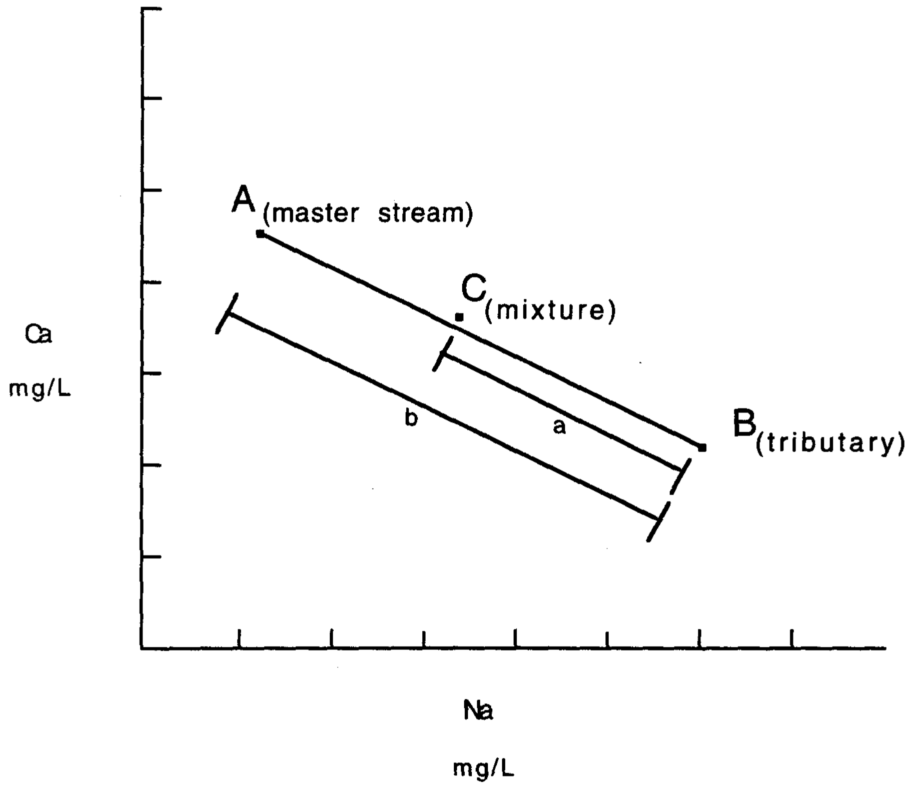



Figure 2a. Sample Na-Ca diagram illustrating the geometric relationship of percent contributions to the mixture from each component. A is the master stream component. B is the tributary component. C is the mixture of the two components.
Percent of the tributary component in the mixture is the ratio of a/b x (100).

| Mixing Diagram | Abundance of Paint Creek Water |
|---|---|
| Na - Ca | 25.0% |
| Na - Mg | 20.0% |
| Na - S | 22.6% |
| Na - K | 23.3% |
| Na - Sr | 20.6% |
| **Average** | **22.3 ± 2.03** |

The data indicate that about 22.3% of the water in the Scioto River below the confluence is derived from Paint Creek. The discharge of the Paint Creek can be calculated from this result by knowing the Scioto River discharge above the confluence using the equation:

$$\frac{\text{(Paint Creek discharge)}}{\text{(Scioto discharge above confluence)} + \text{(Paint Creek discharge)}} = .223 \pm 0.0203 \quad (1)$$

Data obtained from the Water Resources Division of the U.S. Geological Survey reveal that the monthly mean discharge (daily values were not available) of the Scioto River in Chillicothe during August 1994 was 946 cubic feet per second (cfs). This value yields an estimate of 271 cfs ± 31 cfs for the discharge of Paint Creek. The actual mean discharge for August, 1994 was 205 cfs. This means that about 18% of the Scioto waters below the confluence was derived from the Paint Creek. Therefore, the numbers obtained from the mixing model over-estimate the discharge of Paint Creek by an error of 24%.

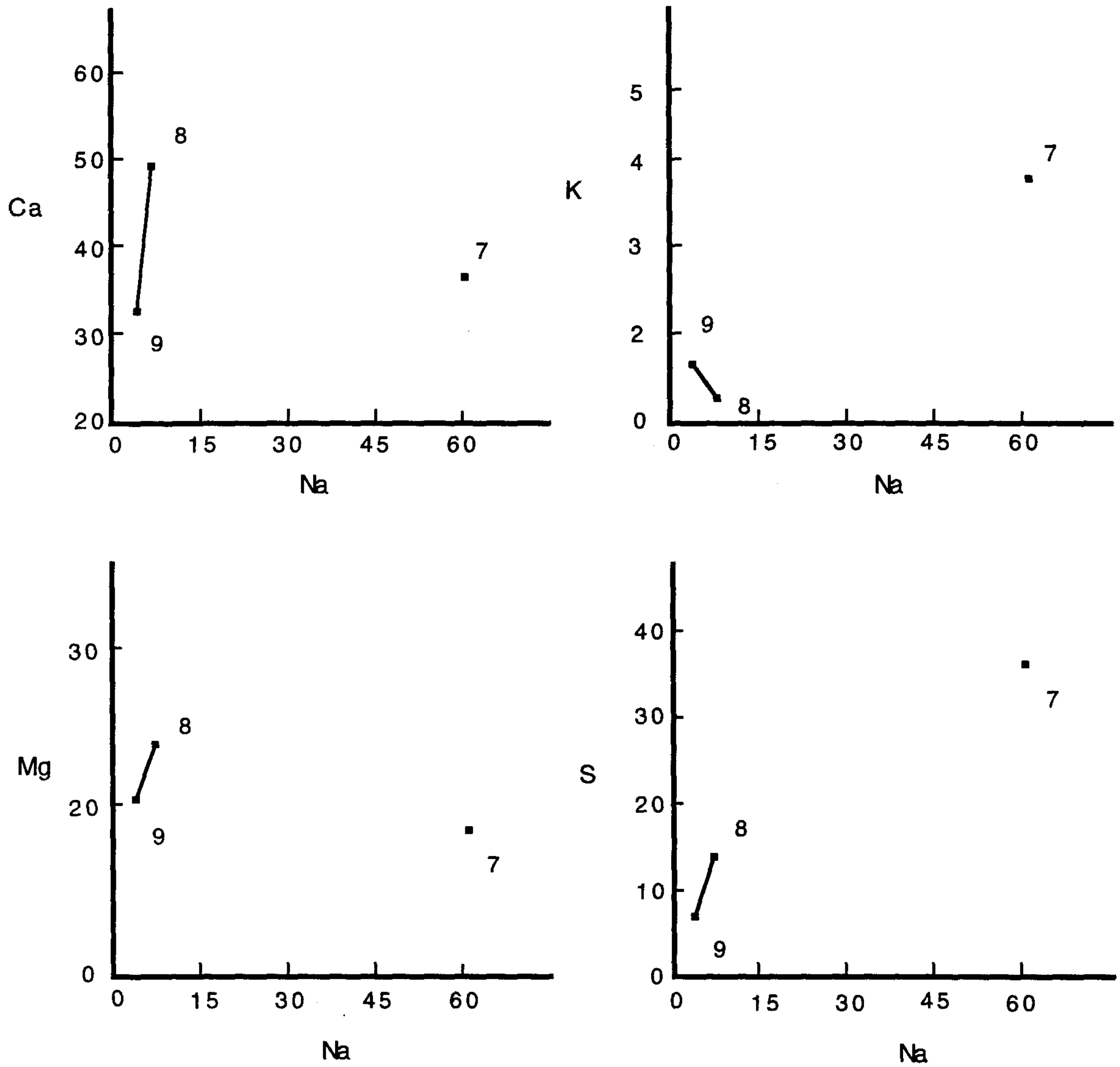
**Anthropogenic Effects**

Samples taken from the northern and southern branches of the Paint Creek (samples 8 and 9), as well as from Paint Creek (sample 7) below the confluence of the two branches are shown in Figure 3. A mixing line was drawn between the two components, but in this case, sample 7, which was taken below the confluence, lies well off the mixing line in the direction of higher Na concentrations. The Na-S diagram shows evidence of increased S concentration as well.

The lack of linearity of the data points in Figure 3 indicates that a third component is affecting sample 7. Since there are no natural inputs of surface water between the confluence and the collecting sites, I conclude that anthropogenic effluent is entering Paint Creek and is altering both the Na and S concentrations of the water.

The Mead paper plant lies within the city limits of Chillicothe and may be the source of the third component of water in Paint Creek. Pulp for the manufacture of paper is prepared by two chemical processes based on the use of either Na sulfate or sulfite to break up cellulose fibers in wood. The discharge of waste water containing these compounds into the Paint Creek can account for increased Na and S concentrations observed in Figure 3.

Information on the chemical composition of the effluent from the Mead plant was obtained from the Ohio EPA, but



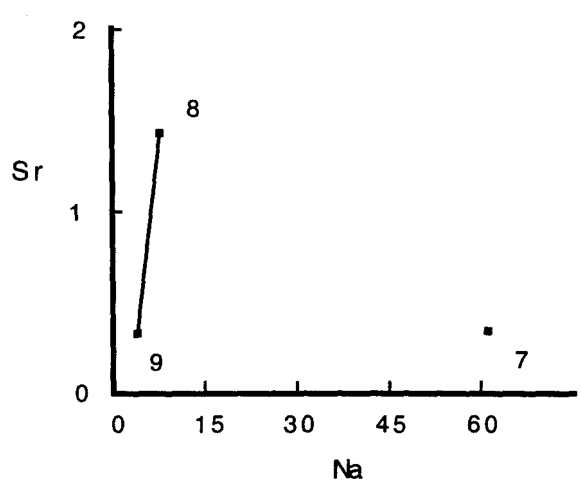




Figure 3. Concentration of element pairs in water of the north and south branches of the Paint Creek. Sample 7: Paint creek below confluence of north and south branches, sample 8: north branch of Paint Creek, sample 9: southern branch of Paint Creek. Analytical errors are given by size of the symbols. All units in ppm.

lacked the Na and S concentrations because these elements are unreactive in solution and are not monitored in effluent as closely as other potentially toxic ions.

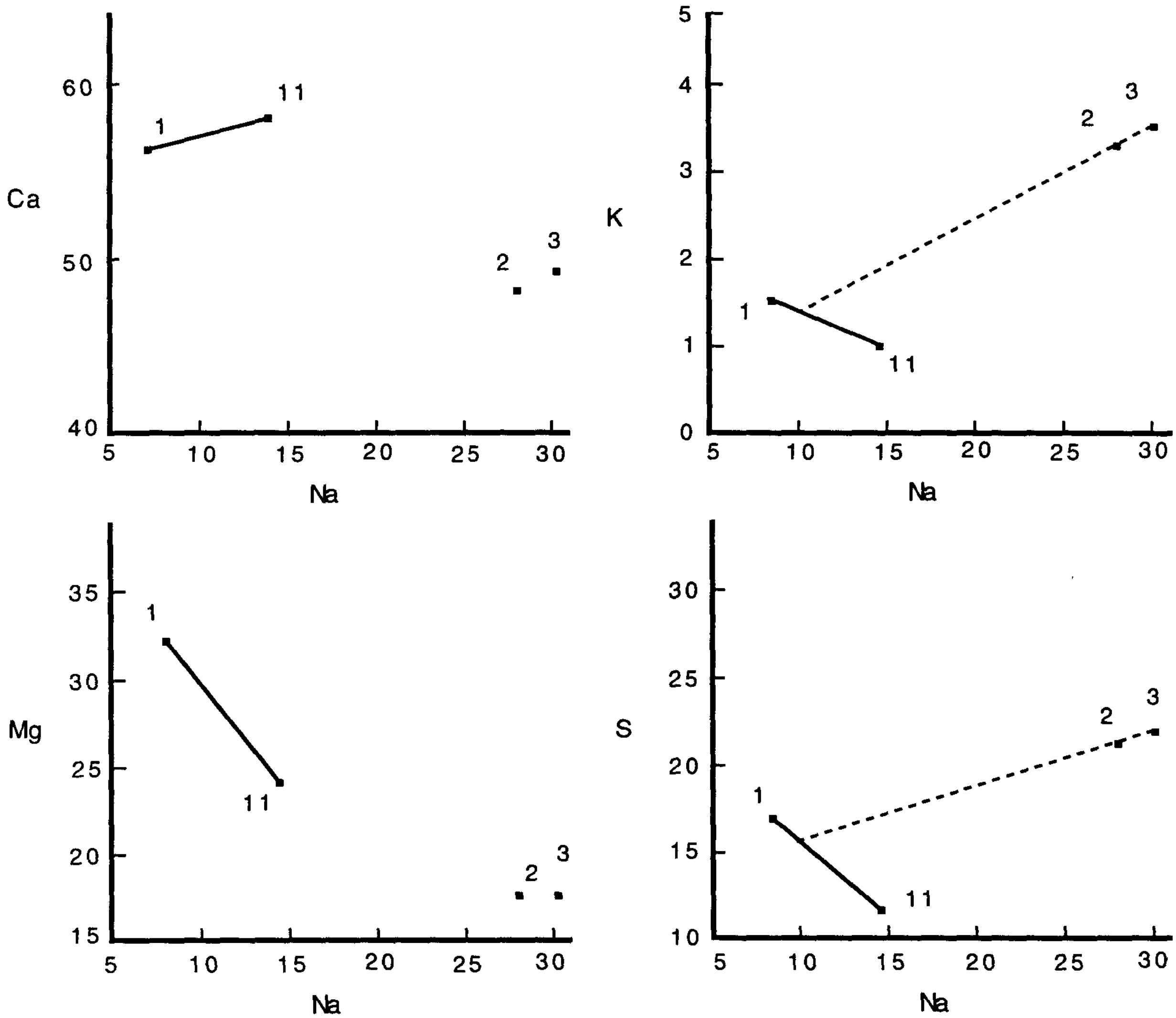
**Scioto River-Deer Creek Confluence**

The Deer Creek-Scioto River diagrams in Figure 4 contain samples 1 (Deer Creek) and 11 (Scioto River above the confluence) as well as samples 2 and 3 below the confluence. These samples (2 and 3) are enriched in Na, S, and K, but depleted in Mg, Ca, and Sr compared to the expected composition predicted by mixing. The diagrams permit the conclusion that a source rich in K, Na, and S has entered the river at a point below the confluence.

The explanation for the deviation of the samples from the predicted mixture is that three tributaries enter the river below the confluence but upstream of the collecting sites on the Scioto River. (see Figure 1) The addition of these waters may increase the concentrations of some elements in the master stream. To study the effects of these tributaries on the composition of water in the Scioto River, more information needs to be obtained from this area.

**Concentrations as a Function of Distance**

Evidence for the accumulation of Na and S in Scioto River waters is given in Figures 5 and 6. The trend indicates that as water flows downstream, Na and S concentrations rise. Since Na and S are essentially harmless



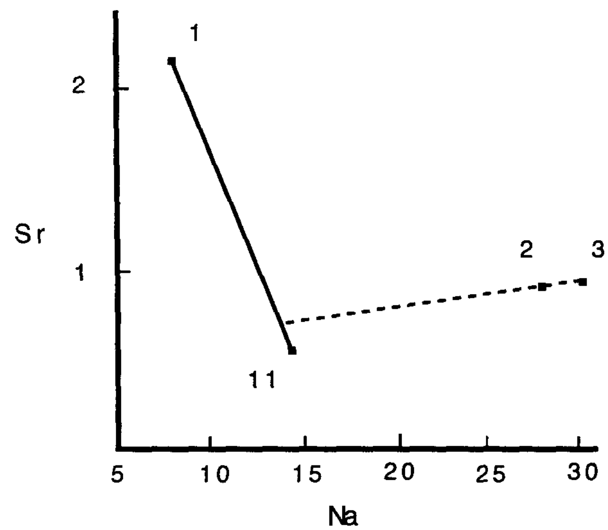




Figure 4. Concentration of element pairs in water of the Scioto River and Deer Creek, Chillicothe, Ohio. Sample 11: Scioto River above the confluence, sample 1: Deer Creek, sample 2: Scioto River below the confluence, sample 3: Scioto River below sample 2. Analytical errors are given by size of the symbols. All units in ppm.

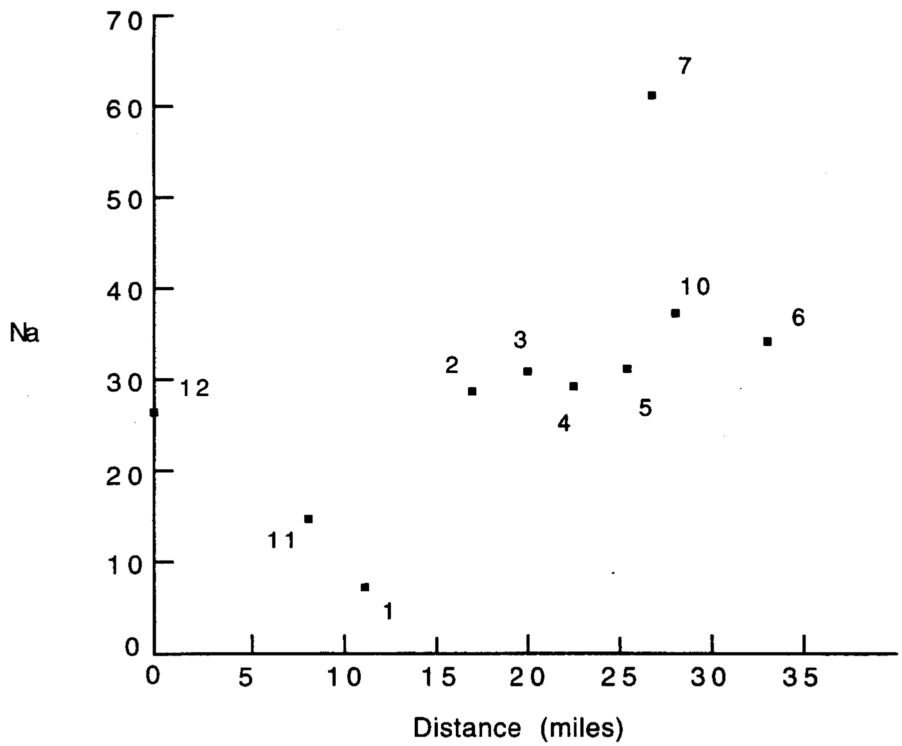



Figure 5. Concentration of sodium in the Scioto River as a function of distance. (Sample 1: Deer Creek concentration, sample 7: Paint Creek concentration). Analytical errors are given by size of the symbol. All concentrations in ppm.

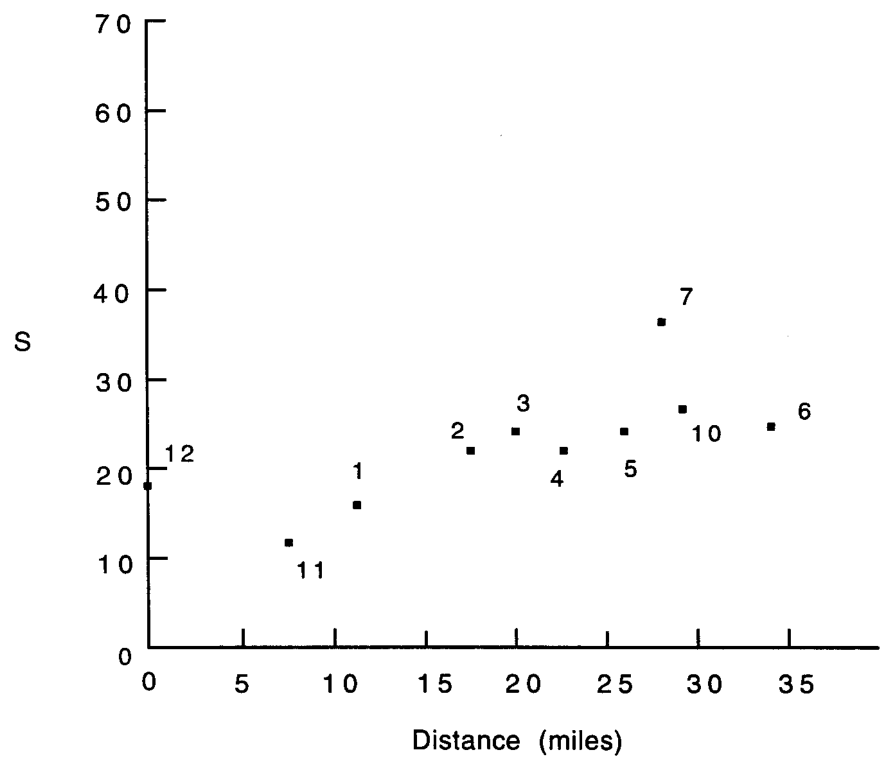



Figure 6. Concentration of total sulfur in the Scioto River as a function of distance. (Sample 1: Deer Creek concentration, sample 7: Paint Creek concentration). Analytical errors are given by size of the symbols. All concentrations in ppm.

to organisms, they are not monitored in industrial effluent and their concentrations therefore pose no threat to public health.

The concentrations of Ca and Mg decrease downstream. (see Figures 7 and 8) I assume that Ca and Mg are not precipitating out, but that their concentrations are being diluted progressively downstream by the increasing discharge of the Scioto River. This hypothesis is confirmed by comparing the discharge of the Scioto River in Chillicothe (946 cfs) and at Higby in southern Ross county (1565 cfs). (USGS, 1994) The increase in discharge of the Scioto River can be attributed to six additional tributaries (including the Paint Creek) that enter the river between Chillicothe and Higby. (see Figure 1)

Therefore, without (anthropogenic) addition of Ca or Mg between Chillicothe and Higby, the concentrations of these elements decrease downstream. The increasing concentrations of Na and S indicate that these elements are overcoming the dilution caused by the increased discharge allowing their concentrations to increase downstream. Therefore, anthropogenic effluent would seem to be the cause of these anomalous trends noted previously by Hicks (1994) who reported increasing Na concentrations for most of the course of the Scioto River.

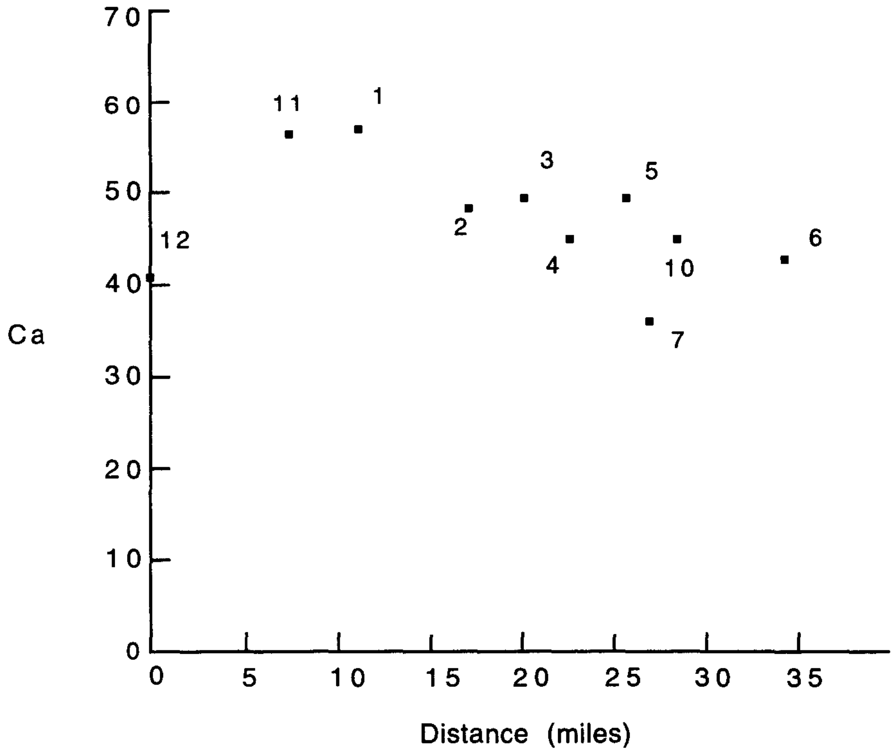



Figure 7. Concentration of calcium in the Scioto River as a function of distance. (Sample 1: Deer Creek concentration, sample 7: Paint Creek concentration). Analytical errors are given by size of the symbol. All concentrations in ppm.

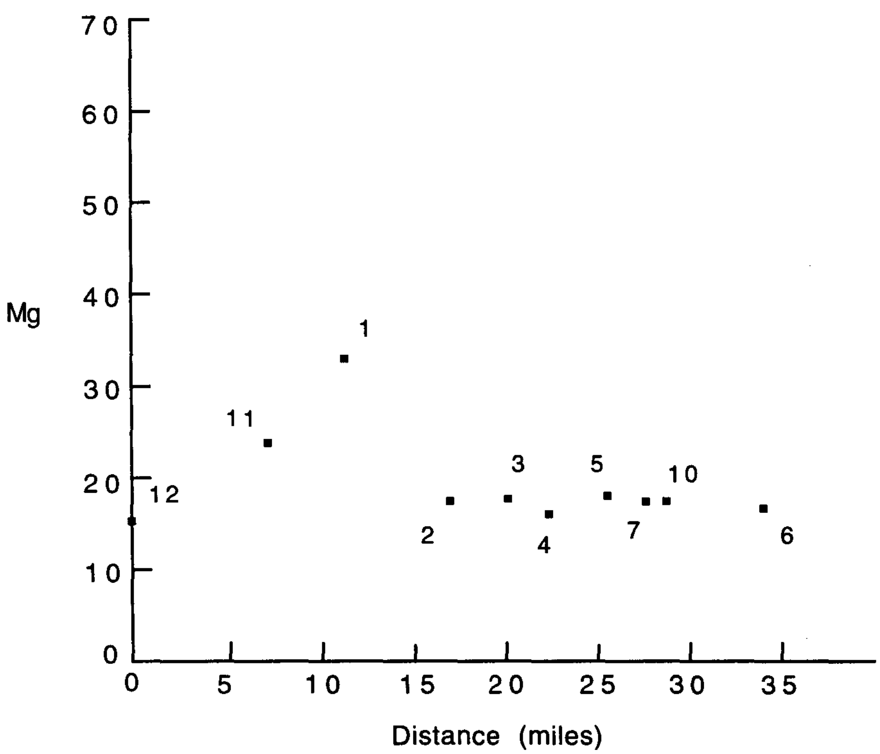



Figure 8. Concentration of magnesium in the Scioto River as a function of distance. (Sample 1: Deer Creek concentration, sample 7: Paint Creek concentration). Analytical errors are given by size of the symbols. All concentrations in ppm.

## SUMMARY OF CONCLUSIONS

The chemical composition of water in the Scioto River and its tributaries in and around Chillicothe can be accounted for by mixing of up to three components. I was able to model two-component mixing with data from the Scioto River-Paint Creek confluence. The mixing diagrams were used to estimate the discharge from the Paint Creek into the Scioto River. The resulting estimate is the discharge on the day the samples were collected and therefore differs by about 24% from the average discharge for August, 1994.

Mixing models of the North-South branches of Paint Creek and of the Scioto River-Deer Creek confluence revealed that a third component is affecting the water at these localities. Anthropogenic effluent was found to be contributing Na and S to Paint Creek. The Scioto-Deer Creek confluence requires additional study because the presence of elevated concentrations of Na, K, and S is probably attributable to the discharge of three tributaries below the Deer Creek-Scioto River confluence.

Samples taken along the course of the Scioto River in the study area revealed that concentrations of elements vary with distance downstream: Na and S concentrations increase, whereas Ca and Mg decrease. I propose that dilution is occurring progressively downstream resulting from increased discharge of the Scioto River from Chillicothe to Higby.

(USGS, 1994) Because Ca and Mg are not being added in substantial quantities, either naturally or anthropogenically, their concentrations decline downstream. Sodium and S are added by anthropogenic effluent in amounts that offset, and in fact overcome, the dilution effect.

**ACKNOWLEDGEMENTS**

I thank Dr. Gunter Faure for advising and guiding the research, without whom I would not have been able to initiate or complete such an undertaking. For aiding me in laboratory procedures and analysis, I thank Dr. John Olesik and Kurt Thaxton. Dr. Olesik provided me with the equipment on which to analyze the samples, and Mr. Thaxton helped me with the operation of the ICP-MS. I also thank both Martha Spurbeck and Kathy Jones of the Ohio EPA who made data available to me both graciously and promptly. I thank Ron Veley from the U.S. Geological Survey-Water Resources Division. To my family: Timothy, Sandra, and Trisha; I am ever grateful to you for giving me all of the support I needed during my undergraduate career. Lastly, but certainly not least, I wish to thank Cherie Colton who helped in field research, editing, computer work, and putting up with me for the last year. To her I am forever in debt.

**REFERENCES**

Hicks, James Edward. Mixing and Anthropogenic Influences on the Chemical Composition of Water Along the Course of the Scioto River, Ohio. Masters Thesis, The Ohio State University, 1994.

Veley, Ron. Scioto River Basin Discharge in Cubic Feet per Second, October 1993 to September 1994, Daily Values. United States Geological Survey-Water Resources Division, Columbus, Ohio.

# APPENDICES

## Output data from the ICP-MS

(Tables 1 - 18)

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

Data Set: kkt-geoH2O1118
Data Set Description: Analysis of Scioto & trib. water; undergrad thesis
Parameter File: kkt-geoH2O1118

Sample ID: 1a
Sample Description:
Sample Type: Sample
Sequence Number: 014
Blank: Subtracted (010)
Dilution Factor: 1
Number of Repeats: 6
Time: 14:54:05 Nov 18 1994
Signal Profile Processing: Average
Spectral Peak Processing: Average
Deadtime Correction: 35

Calibration File: kkt-geoH2O-1
Calibration: External Standard

| | Sample Intensity | Std. Dev. | Blank Intensity | Std. Dev. |
|---|---|---|---|---|
| Na 23 | 273965 | 6616.2622 | 104699 | 1020.1544 |
| Mg 24 | 406262 | 1.512E+04 | 146 | 16.8900 |
| S 34 | 129713 | 2187.3203 | 27015 | 124.5347 |
| K 39 | 135352 | 3857.3369 | 36208 | 338.9833 |
| Ca 44 | 268666 | 1.028E+04 | 218 | 17.1502 |
| Se 78 | 1804 | 36.7056 | 1970 | 33.2034 |
| Sr 88 | 657620 | 2.180E+04 | 70 | 20.3355 |

| | Net Ratio/ Intensity | Std. Dev. | Conc. | Std. Dev. | | % RSD |
|---|---|---|---|---|---|---|
| Na 23 | 169266 | 6694.4482 | 7.4285 | 0.3941 | ppm | 5.3058 |
| Mg 24 | 406116 | 1.512E+04 | 32.1711 | 1.3535 | ppm | 4.2072 |
| S 34 | 102698 | 2190.8625 | 16.8230 | 0.4282 | ppm | 2.5451 |
| K 39 | 99145 | 3872.2031 | 1.5575 | 0.0806 | ppm | 5.1746 |
| Ca 44 | 268448 | 1.028E+04 | 56.6842 | 2.1959 | ppm | 3.8739 |
| Se 78 | -166 | 49.4951 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 657550 | 2.180E+04 | 2.1122 | 0.0712 | ppm | 3.3714 |

Table 1. Analysis of sample 1.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

| | |
|---|---|
| Data Set: | kkt-geoH2O1118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH2O1118 |
| Sample ID: | 2a |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 015 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 14:59:33 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 626845 | 1.170E+04 | 104699 | 1020.1544 |
| Mg 24 | 241066 | 4193.8706 | 146 | 16.8900 |
| S 34 | 151848 | 1972.7899 | 27015 | 124.5347 |
| K 39 | 219235 | 4953.0342 | 36208 | 338.9833 |
| Ca 44 | 231218 | 5874.3398 | 218 | 17.1502 |
| Se 78 | 1674 | 24.1356 | 1970 | 33.2034 |
| Sr 88 | 293085 | 6099.3018 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 522146 | 1.175E+04 | 28.2045 | 0.6917 | ppm | 2.4526 |
| Mg 24 | 240921 | 4193.9048 | 17.3859 | 0.3754 | ppm | 2.1590 |
| S 34 | 124833 | 1976.7167 | 21.1489 | 0.3863 | ppm | 1.8266 |
| K 39 | 183027 | 4964.6206 | 3.3034 | 0.1033 | ppm | 3.1280 |
| Ca 44 | 230999 | 5874.3647 | 48.6856 | 1.2547 | ppm | 2.5771 |
| Se 78 | -296 | 41.0486 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 293015 | 6099.3354 | 0.9212 | 0.0199 | ppm | 2.1630 |

Table 2. Analysis of sample 2.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

| | |
|---|---|
| Data Set: | kkt-geoH2O1118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH2O1118 |

| | |
|---|---|
| Sample ID: | dilstd |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 016 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 15:04:16 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |

| | |
|---|---|
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 242407 | 5025.1499 | 104699 | 1020.1544 |
| Mg 24 | 188611 | 5804.6440 | 146 | 16.8900 |
| S 34 | 214418 | 7535.9150 | 27015 | 124.5347 |
| K 39 | 128951 | 3838.0847 | 36208 | 338.9833 |
| Ca 44 | 148147 | 6355.8066 | 218 | 17.1502 |
| Se 78 | 6192 | 168.7850 | 1970 | 33.2034 |
| Sr 88 | 248862 | 1.259E+04 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 137708 | 5127.6553 | 5.5705 | 0.3019 | ppm | 5.4195 |
| Mg 24 | 188465 | 5804.6685 | 12.6910 | 0.5195 | ppm | 4.0936 |
| S 34 | 187403 | 7536.9438 | 33.3771 | 1.4730 | ppm | 4.4131 |
| K 39 | 92744 | 3853.0254 | 1.4243 | 0.0802 | ppm | 5.6306 |
| Ca 44 | 147929 | 6355.8296 | 30.9428 | 1.3575 | ppm | 4.3872 |
| Se 78 | 4222 | 172.0199 | 0.0345 | 1.709E-03 | ppm | 4.9543 |
| Sr 88 | 248792 | 1.259E+04 | 0.7768 | 0.0411 | ppm | 5.2972 |

Table 3. Analysis of standard solution for ICP-MS calibration.

# QUANTITATIVE ANALYSIS: SUMMARY REPORT

| | |
|---|---|
| Data Set: | kkt-geoH2O1118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH2O1118 |
| Sample ID: | 3a |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 017 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 15:09:01 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 667376 | 7958.5093 | 104699 | 1020.1544 |
| Mg 24 | 246075 | 8205.1309 | 146 | 16.8900 |
| S 34 | 159128 | 3549.3103 | 27015 | 124.5347 |
| K 39 | 230265 | 5841.3003 | 36208 | 338.9833 |
| Ca 44 | 234921 | 8957.4814 | 218 | 17.1502 |
| Se 78 | 1685 | 27.9971 | 1970 | 33.2034 |
| Sr 88 | 299271 | 9924.2012 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 562677 | 8023.6265 | 30.5908 | 0.4724 | ppm | 1.5442 |
| Mg 24 | 245929 | 8205.1484 | 17.8341 | 0.7344 | ppm | 4.1178 |
| S 34 | 132113 | 3551.4944 | 22.5717 | 0.6941 | ppm | 3.0750 |
| K 39 | 194057 | 5851.1279 | 3.5329 | 0.1218 | ppm | 3.4470 |
| Ca 44 | 234703 | 8957.4980 | 49.4765 | 1.9132 | ppm | 3.8669 |
| Se 78 | -285 | 43.4315 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 299201 | 9924.2217 | 0.9415 | 0.0324 | ppm | 3.4439 |

Table 4. Analysis of sample 3.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

| | |
|---|---|
| Data Set: | kkt-geoH2O1118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH2O1118 |
| Sample ID: | 4a |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 018 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 15:14:03 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 636260 | 6137.1289 | 104699 | 1020.1544 |
| Mg 24 | 231895 | 3964.3030 | 146 | 16.8900 |
| S 34 | 150771 | 702.8731 | 27015 | 124.5347 |
| K 39 | 219582 | 1889.4757 | 36208 | 338.9833 |
| Ca 44 | 218612 | 1691.5425 | 218 | 17.1502 |
| Se 78 | 1672 | 26.7958 | 1970 | 33.2034 |
| Sr 88 | 283508 | 666.9625 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 531561 | 6221.3394 | 28.7589 | 0.3663 | ppm | 1.2736 |
| Mg 24 | 231749 | 3964.3389 | 16.5650 | 0.3548 | ppm | 2.1419 |
| S 34 | 123756 | 713.8204 | 20.9385 | 0.1395 | ppm | 0.6663 |
| K 39 | 183374 | 1919.6427 | 3.3106 | 0.0400 | ppm | 1.2069 |
| Ca 44 | 218394 | 1691.6294 | 45.9932 | 0.3613 | ppm | 0.7856 |
| Se 78 | -298 | 42.6671 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 283438 | 667.2724 | 0.8900 | 2.180E-03 | ppm | 0.2450 |

Table 5. Analysis of sample 4.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

Data Set: kkt-geoH2O1118
Data Set Description: Analysis of Scioto & trib. water; undergrad thesis
Parameter File: kkt-geoH2O1118

Sample ID: dilstd2
Sample Description:
Sample Type: Sample
Sequence Number: 019
Blank: Subtracted (010)
Dilution Factor: 1
Number of Repeats: 6
Time: 15:18:39 Nov 18 1994
Signal Profile Processing: Average
Spectral Peak Processing: Average
Deadtime Correction: 35

Calibration File: kkt-geoH2O-1
Calibration: External Standard

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 238482 | 3837.0754 | 104699 | 1020.1544 |
| Mg 24 | 185179 | 3835.1804 | 146 | 16.8900 |
| S 34 | 210964 | 5445.7661 | 27015 | 124.5347 |
| K 39 | 126146 | 3183.1699 | 36208 | 338.9833 |
| Ca 44 | 143834 | 4805.1904 | 218 | 17.1502 |
| Se 78 | 6197 | 82.8667 | 1970 | 33.2034 |
| Sr 88 | 241511 | 8555.1016 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 133783 | 3970.3730 | 5.3394 | 0.2338 | ppm | 4.3780 |
| Mg 24 | 185033 | 3835.2175 | 12.3839 | 0.3433 | ppm | 2.7718 |
| S 34 | 183949 | 5447.1899 | 32.7021 | 1.0645 | ppm | 3.2553 |
| K 39 | 89938 | 3201.1687 | 1.3659 | 0.0666 | ppm | 4.8780 |
| Ca 44 | 143616 | 4805.2212 | 30.0215 | 1.0263 | ppm | 3.4187 |
| Se 78 | 4227 | 89.2712 | 0.0346 | 8.872E-04 | ppm | 2.5674 |
| Sr 88 | 241441 | 8555.1260 | 0.7528 | 0.0279 | ppm | 3.7130 |

Table 6. Analysis of standard for ICP-MS calibration.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

Data Set: kkt-geoH2O1118
Data Set Description: Analysis of Scioto & trib. water; undergrad thesis
Parameter File: kkt-geoH2O1118

Sample ID: 5a
Sample Description:
Sample Type: Sample
Sequence Number: 020
Blank: Subtracted (010)
Dilution Factor: 1
Number of Repeats: 6
Time: 15:25:17 Nov 18 1994
Signal Profile Processing: Average
Spectral Peak Processing: Average
Deadtime Correction: 35

Calibration File: kkt-geoH2O-1
Calibration: External Standard

| | Sample Intensity | Std. Dev. | Blank Intensity | Std. Dev. |
|---|---|---|---|---|
| Na 23 | 669954 | 1.691E+04 | 104699 | 1020.1544 |
| Mg 24 | 250044 | 7441.2031 | 146 | 16.8900 |
| S 34 | 159049 | 3271.5764 | 27015 | 124.5347 |
| K 39 | 230351 | 7311.6470 | 36208 | 338.9833 |
| Ca 44 | 235530 | 8830.0107 | 218 | 17.1502 |
| Se 78 | 1685 | 12.4301 | 1970 | 33.2034 |
| Sr 88 | 294294 | 7875.4536 | 70 | 20.3355 |

| | Net Ratio/ Intensity | Std. Dev. | Conc. | Std. Dev. | | % RSD |
|---|---|---|---|---|---|---|
| Na 23 | 565255 | 1.695E+04 | 30.7426 | 0.9977 | ppm | 3.2452 |
| Mg 24 | 249898 | 7441.2222 | 18.1893 | 0.6660 | ppm | 3.6615 |
| S 34 | 132034 | 3273.9458 | 22.5563 | 0.6398 | ppm | 2.8366 |
| K 39 | 194143 | 7319.5010 | 3.5347 | 0.1523 | ppm | 4.3099 |
| Ca 44 | 235312 | 8830.0273 | 49.6067 | 1.8860 | ppm | 3.8019 |
| Se 78 | -285 | 35.4538 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 294224 | 7875.4800 | 0.9252 | 0.0257 | ppm | 2.7810 |

Table 7. Analysis of sample 5.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**



| | |
|---|---|
| Data Set: | kkt-geoH201118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH201118 |
| | |
| Sample ID: | 6a |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 021 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 15:29:59 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |
| | |
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 728936 | 3895.6633 | 104699 | 1020.1544 |
| Mg 24 | 232405 | 2602.7444 | 146 | 16.8900 |
| S 34 | 163630 | 651.9040 | 27015 | 124.5347 |
| K 39 | 207310 | 876.2852 | 36208 | 338.9833 |
| Ca 44 | 205784 | 1526.8174 | 218 | 17.1502 |
| Se 78 | 1643 | 26.2151 | 1970 | 33.2034 |
| Sr 88 | 225654 | 1359.0880 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 624237 | 4027.0222 | 34.2152 | 0.2371 | ppm | 0.6929 |
| Mg 24 | 232259 | 2602.7991 | 16.6107 | 0.2330 | ppm | 1.4024 |
| S 34 | 136615 | 663.6925 | 23.4515 | 0.1297 | ppm | 0.5531 |
| K 39 | 171102 | 939.5666 | 3.0552 | 0.0196 | ppm | 0.6401 |
| Ca 44 | 205566 | 1526.9137 | 43.2533 | 0.3261 | ppm | 0.7540 |
| Se 78 | -327 | 42.3048 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 225584 | 1359.2401 | 0.7009 | 4.441E-03 | ppm | 0.6335 |

Table 8. Analysis of sample 6.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

Data Set: kkt-geoH2O1118
Data Set Description: Analysis of Scioto & trib. water; undergrad thesis
Parameter File: kkt-geoH2O1118

Sample ID: dilstd3
Sample Description:
Sample Type: Sample
Sequence Number: 022
Blank: Subtracted (010)
Dilution Factor: 1
Number of Repeats: 6
Time: 15:35:06 Nov 18 1994
Signal Profile Processing: Average
Spectral Peak Processing: Average
Deadtime Correction: 35

Calibration File: kkt-geoH2O-1
Calibration: External Standard

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 235094 | 4311.1138 | 104699 | 1020.1544 |
| Mg 24 | 180444 | 5002.6768 | 146 | 16.8900 |
| S 34 | 206260 | 6171.6475 | 27015 | 124.5347 |
| K 39 | 123724 | 3317.2346 | 36208 | 338.9833 |
| Ca 44 | 140346 | 5426.7373 | 218 | 17.1502 |
| Se 78 | 6083 | 83.8836 | 1970 | 33.2034 |
| Sr 88 | 233797 | 9040.2324 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 130395 | 4430.1714 | 5.1400 | 0.2608 | ppm | 5.0745 |
| Mg 24 | 180298 | 5002.7051 | 11.9601 | 0.4477 | ppm | 3.7437 |
| S 34 | 179245 | 6172.9038 | 31.7828 | 1.2064 | ppm | 3.7957 |
| K 39 | 87516 | 3334.5098 | 1.3155 | 0.0694 | ppm | 5.2759 |
| Ca 44 | 140128 | 5426.7646 | 29.2765 | 1.1591 | ppm | 3.9591 |
| Se 78 | 4112 | 90.2159 | 0.0334 | 8.965E-04 | ppm | 2.6828 |
| Sr 88 | 233727 | 9040.2549 | 0.7275 | 0.0295 | ppm | 4.0595 |

Table 9. Analysis of standard solution for ICP-MS calibration.

## QUANTITATIVE ANALYSIS: SUMMARY REPORT



| | |
|---|---|
| Data Set: | kkt-geoH2O1118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH2O1118 |
| Sample ID: | 7a |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 023 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 15:40:01 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | Sample Intensity | Std. Dev. | Blank Intensity | Std. Dev. |
|---|---|---|---|---|
| Na 23 | 1194375 | 2.370E+04 | 104699 | 1020.1544 |
| Mg 24 | 244461 | 6293.7100 | 146 | 16.8900 |
| S 34 | 226386 | 4515.8574 | 27015 | 124.5347 |
| K 39 | 242950 | 6493.2251 | 36208 | 338.9833 |
| Ca 44 | 174974 | 4277.3818 | 218 | 17.1502 |
| Se 78 | 1668 | 27.2791 | 1970 | 33.2034 |
| Sr 88 | 123959 | 2788.2439 | 70 | 20.3355 |

| | Net Ratio/ Intensity | Std. Dev. | Conc. | Std. Dev. | | % RSD |
|---|---|---|---|---|---|---|
| Na 23 | 1089676 | 2.373E+04 | 61.6182 | 1.3968 | ppm | 2.2669 |
| Mg 24 | 244315 | 6293.7324 | 17.6897 | 0.5633 | ppm | 3.1843 |
| S 34 | 199371 | 4517.5742 | 35.7161 | 0.8829 | ppm | 2.4719 |
| K 39 | 206742 | 6502.0674 | 3.7970 | 0.1353 | ppm | 3.5642 |
| Ca 44 | 174756 | 4277.4160 | 36.6727 | 0.9136 | ppm | 2.4912 |
| Se 78 | -302 | 42.9722 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 123889 | 2788.3181 | 0.3687 | 9.110E-03 | ppm | 2.4707 |

Table 10. Analysis of sample 7.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

| | |
|---|---|
| Data Set: | kkt-geoH2O1118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH2O1118 |
| Sample ID: | 8a |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 024 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 15:44:35 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 258379 | 1959.7562 | 104699 | 1020.1544 |
| Mg 24 | 343713 | 3796.6919 | 146 | 16.8900 |
| S 34 | 110238 | 1598.9337 | 27015 | 124.5347 |
| K 39 | 130344 | 1962.7412 | 36208 | 338.9833 |
| Ca 44 | 232196 | 4873.5132 | 218 | 17.1502 |
| Se 78 | 1645 | 14.8024 | 1970 | 33.2034 |
| Sr 88 | 457786 | 1.098E+04 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 153680 | 2209.3799 | 6.5109 | 0.1301 | ppm | 1.9979 |
| Mg 24 | 343567 | 3796.7295 | 26.5728 | 0.3398 | ppm | 1.2788 |
| S 34 | 83223 | 1603.7761 | 13.0170 | 0.3134 | ppm | 2.4078 |
| K 39 | 94137 | 1991.7988 | 1.4532 | 0.0415 | ppm | 2.8526 |
| Ca 44 | 231978 | 4873.5435 | 48.8947 | 1.0409 | ppm | 2.1289 |
| Se 78 | -325 | 36.3534 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 457716 | 1.098E+04 | 1.4593 | 0.0359 | ppm | 2.4586 |

Table 11. Analysis of sample 8.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

Data Set: kkt-geoH2O1118
Data Set Description: Analysis of Scioto & trib. water; undergrad thesis
Parameter File: kkt-geoH2O1118

Sample ID: dilstd4
Sample Description:
Sample Type: Sample
Sequence Number: 025
Blank: Subtracted (010)
Dilution Factor: 1
Number of Repeats: 6
Time: 15:49:46 Nov 18 1994
Signal Profile Processing: Average
Spectral Peak Processing: Average
Deadtime Correction: 35

Calibration File: kkt-geoH2O-1
Calibration: External Standard

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 247531 | 2717.1157 | 104699 | 1020.1544 |
| Mg 24 | 192716 | 3524.2930 | 146 | 16.8900 |
| S 34 | 223420 | 3890.6143 | 27015 | 124.5347 |
| K 39 | 132943 | 2163.0303 | 36208 | 338.9833 |
| Ca 44 | 156038 | 3534.9878 | 218 | 17.1502 |
| Se 78 | 6480 | 119.4783 | 1970 | 33.2034 |
| Sr 88 | 260947 | 8687.6650 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 142832 | 2902.3152 | 5.8722 | 0.1709 | ppm | 2.9099 |
| Mg 24 | 192570 | 3524.3335 | 13.0584 | 0.3154 | ppm | 2.4155 |
| S 34 | 196405 | 3892.6069 | 35.1364 | 0.7607 | ppm | 2.1651 |
| K 39 | 96735 | 2189.4314 | 1.5073 | 0.0456 | ppm | 3.0232 |
| Ca 44 | 155820 | 3535.0293 | 32.6283 | 0.7550 | ppm | 2.3141 |
| Se 78 | 4510 | 124.0061 | 0.0374 | 1.232E-03 | ppm | 3.2980 |
| Sr 88 | 260877 | 8687.6885 | 0.8162 | 0.0284 | ppm | 3.4773 |

Table 12. Analysis of standard solution for ICP-MS calibration.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

| | |
|---|---|
| Data Set: | kkt-geoH2O1118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH2O1118 |
| | |
| Sample ID: | 9a |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 026 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 15:59:27 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |
| | |
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 221126 | 3236.2219 | 104699 | 1020.1544 |
| Mg 24 | 277026 | 5360.5356 | 146 | 16.8900 |
| S 34 | 76065 | 1027.8345 | 27015 | 124.5347 |
| K 39 | 140670 | 2531.0117 | 36208 | 338.9833 |
| Ca 44 | 161406 | 4103.2427 | 218 | 17.1502 |
| Se 78 | 1715 | 36.7185 | 1970 | 33.2034 |
| Sr 88 | 125176 | 3024.7854 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 116427 | 3393.2061 | 4.3176 | 0.1998 | ppm | 4.6271 |
| Mg 24 | 276880 | 5360.5620 | 20.6043 | 0.4798 | ppm | 2.3285 |
| S 34 | 49050 | 1035.3514 | 6.3386 | 0.2023 | ppm | 3.1922 |
| K 39 | 104462 | 2553.6111 | 1.6682 | 0.0531 | ppm | 3.1861 |
| Ca 44 | 161188 | 4103.2783 | 33.7748 | 0.8764 | ppm | 2.5949 |
| Se 78 | -256 | 49.5047 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 125106 | 3024.8538 | 0.3727 | 9.882E-03 | ppm | 2.6517 |

Table 13. Analysis of sample 9.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

| | |
|---|---|
| Data Set: | kkt-geoH2O1118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH2O1118 |
| Sample ID: | 10a |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 027 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 16:04:59 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 772827 | 7193.7407 | 104699 | 1020.1544 |
| Mg 24 | 242745 | 2194.1338 | 146 | 16.8900 |
| S 34 | 169795 | 638.6733 | 27015 | 124.5347 |
| K 39 | 222134 | 1995.2152 | 36208 | 338.9833 |
| Ca 44 | 211500 | 3309.8889 | 218 | 17.1502 |
| Se 78 | 1668 | 41.7778 | 1970 | 33.2034 |
| Sr 88 | 233907 | 2298.2847 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 668128 | 7265.7153 | 36.7993 | 0.4278 | ppm | 1.1625 |
| Mg 24 | 242599 | 2194.1987 | 17.5361 | 0.1964 | ppm | 1.1199 |
| S 34 | 142780 | 650.7016 | 24.6564 | 0.1272 | ppm | 0.5158 |
| K 39 | 185927 | 2023.8066 | 3.3637 | 0.0421 | ppm | 1.2523 |
| Ca 44 | 211282 | 3309.9333 | 44.4741 | 0.7070 | ppm | 1.5896 |
| Se 78 | -302 | 53.3652 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 233837 | 2298.3745 | 0.7279 | 7.509E-03 | ppm | 1.0316 |

Table 14. Analysis of sample 10.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

Data Set: kkt-geoH201118
Data Set Description: Analysis of Scioto & trib. water; undergrad thesis
Parameter File: kkt-geoH201118

Sample ID: dilstd5
Sample Description:
Sample Type: Sample
Sequence Number: 028
Blank: Subtracted (010)
Dilution Factor: 1
Number of Repeats: 6
Time: 16:09:53 Nov 18 1994
Signal Profile Processing: Average
Spectral Peak Processing: Average
Deadtime Correction: 35

Calibration File: kkt-geoH2O-1
Calibration: External Standard

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 237160 | 4770.8779 | 104699 | 1020.1544 |
| Mg 24 | 186308 | 4210.2275 | 146 | 16.8900 |
| S 34 | 210724 | 6169.7559 | 27015 | 124.5347 |
| K 39 | 124873 | 3407.0149 | 36208 | 338.9833 |
| Ca 44 | 143496 | 5609.7754 | 218 | 17.1502 |
| Se 78 | 6169 | 89.5157 | 1970 | 33.2034 |
| Sr 88 | 238654 | 1.108E+04 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 132461 | 4878.7285 | 5.2616 | 0.2872 | ppm | 5.4592 |
| Mg 24 | 186162 | 4210.2612 | 12.4849 | 0.3768 | ppm | 3.0182 |
| S 34 | 183709 | 6171.0127 | 32.6552 | 1.2060 | ppm | 3.6932 |
| K 39 | 88665 | 3423.8372 | 1.3394 | 0.0713 | ppm | 5.3205 |
| Ca 44 | 143278 | 5609.8018 | 29.9494 | 1.1982 | ppm | 4.0007 |
| Se 78 | 4199 | 95.4753 | 0.0343 | 9.488E-04 | ppm | 2.7680 |
| Sr 88 | 238584 | 1.108E+04 | 0.7434 | 0.0362 | ppm | 4.8681 |

Table 15. Analysis of standard solution for ICP-MS calibration.

## QUANTITATIVE ANALYSIS: SUMMARY REPORT

| | |
|---|---|
| Data Set: | kkt-geoH2O1118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH2O1118 |
| Sample ID: | 11a |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 029 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 16:15:16 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 394319 | 7716.3823 | 104699 | 1020.1544 |
| Mg 24 | 316697 | 7558.1367 | 146 | 16.8900 |
| S 34 | 101899 | 1979.5649 | 27015 | 124.5347 |
| K 39 | 109010 | 2185.4353 | 36208 | 338.9833 |
| Ca 44 | 271318 | 8030.7314 | 218 | 17.1502 |
| Se 78 | 1659 | 17.2259 | 1970 | 33.2034 |
| Sr 88 | 185513 | 4530.6143 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 289620 | 7783.5254 | 14.5144 | 0.4583 | ppm | 3.1573 |
| Mg 24 | 316551 | 7558.1558 | 24.1549 | 0.6765 | ppm | 2.8005 |
| S 34 | 74884 | 1983.4783 | 11.3875 | 0.3876 | ppm | 3.4040 |
| K 39 | 72802 | 2211.5688 | 1.0092 | 0.0460 | ppm | 4.5610 |
| Ca 44 | 271099 | 8030.7500 | 57.2504 | 1.7153 | ppm | 2.9961 |
| Se 78 | -311 | 37.4058 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 185443 | 4530.6597 | 0.5698 | 0.0148 | ppm | 2.5977 |

Table 16. Analysis of sample 11.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

| | |
|---|---|
| Data Set: | kkt-geoH2O1118 |
| Data Set Description: | Analysis of Scioto & trib. water; undergrad thesis |
| Parameter File: | kkt-geoH2O1118 |
| Sample ID: | 12a |
| Sample Description: | |
| Sample Type: | Sample |
| Sequence Number: | 030 |
| Blank: | Subtracted (010) |
| Dilution Factor: | 1 |
| Number of Repeats: | 6 |
| Time: | 16:20:05 Nov 18 1994 |
| Signal Profile Processing: | Average |
| Spectral Peak Processing: | Average |
| Deadtime Correction: | 35 |
| Calibration File: | kkt-geoH2O-1 |
| Calibration: | External Standard |

| | **Sample Intensity** | **Std. Dev.** | **Blank Intensity** | **Std. Dev.** |
|---|---|---|---|---|
| Na 23 | 584384 | 2438.6206 | 104699 | 1020.1544 |
| Mg 24 | 212444 | 2706.7671 | 146 | 16.8900 |
| S 34 | 136542 | 992.7105 | 27015 | 124.5347 |
| K 39 | 199332 | 1493.5933 | 36208 | 338.9833 |
| Ca 44 | 195663 | 1366.2294 | 218 | 17.1502 |
| Se 78 | 1702 | 28.4179 | 1970 | 33.2034 |
| Sr 88 | 296764 | 2028.9023 | 70 | 20.3355 |

| | **Net Ratio/ Intensity** | **Std. Dev.** | **Conc.** | **Std. Dev.** | | **% RSD** |
|---|---|---|---|---|---|---|
| Na 23 | 479685 | 2643.4041 | 25.7046 | 0.1556 | ppm | 0.6055 |
| Mg 24 | 212298 | 2706.8198 | 14.8241 | 0.2423 | ppm | 1.6342 |
| S 34 | 109527 | 1000.4914 | 18.1576 | 0.1955 | ppm | 1.0768 |
| K 39 | 163125 | 1531.5778 | 2.8891 | 0.0319 | ppm | 1.1034 |
| Ca 44 | 195445 | 1366.3370 | 41.0917 | 0.2918 | ppm | 0.7102 |
| Se 78 | -268 | 43.7040 | 0.0000 | n/a | ppm | n/a |
| Sr 88 | 296694 | 2029.0043 | 0.9333 | 6.629E-03 | ppm | 0.7103 |

Table 17. Analysis of sample 12.

**QUANTITATIVE ANALYSIS: SUMMARY REPORT**

Data Set: kkt-geoH2O1118
Data Set Description: Analysis of Scioto & trib. water; undergrad thesis
Parameter File: kkt-geoH2O1118

Sample ID: dilstd6
Sample Description:
Sample Type: Sample
Sequence Number: 031
Blank: Subtracted (010)
Dilution Factor: 1
Number of Repeats: 6
Time: 16:25:13 Nov 18 1994
Signal Profile Processing: Average
Spectral Peak Processing: Average
Deadtime Correction: 35

Calibration File: kkt-geoH2O-1
Calibration: External Standard

| | Sample Intensity | Std. Dev. | Blank Intensity | Std. Dev. |
|---|---|---|---|---|
| Na 23 | 233936 | 3818.6008 | 104699 | 1020.1544 |
| Mg 24 | 184680 | 5092.9907 | 146 | 16.8900 |
| S 34 | 202898 | 6992.0889 | 27015 | 124.5347 |
| K 39 | 121230 | 3398.9167 | 36208 | 338.9833 |
| Ca 44 | 137528 | 5737.7085 | 218 | 17.1502 |
| Se 78 | 6228 | 107.6924 | 1970 | 33.2034 |
| Sr 88 | 227939 | 9238.8730 | 70 | 20.3355 |

| | Net Ratio/ Intensity | Std. Dev. | Conc. | Std. Dev. | | % RSD |
|---|---|---|---|---|---|---|
| Na 23 | 129237 | 3952.5217 | 5.0718 | 0.2327 | ppm | 4.5883 |
| Mg 24 | 184534 | 5093.0186 | 12.3392 | 0.4558 | ppm | 3.6942 |
| S 34 | 175883 | 6993.1978 | 31.1258 | 1.3667 | ppm | 4.3909 |
| K 39 | 85022 | 3415.7788 | 1.2636 | 0.0711 | ppm | 5.6265 |
| Ca 44 | 137310 | 5737.7339 | 28.6747 | 1.2255 | ppm | 4.2738 |
| Se 78 | 4258 | 112.6948 | 0.0349 | 1.120E-03 | ppm | 3.2120 |
| Sr 88 | 227869 | 9238.8955 | 0.7084 | 0.0302 | ppm | 4.2608 |

Table 18. Analysis of standard solution for ICP-MS calibration.